# CAPT Science Performance Task

## Tiny Bubbles

Millions of chemical reactions are occurring in your body all the time. Hydrogen peroxide, $H_2O_2$, a substance that is poisonous to cells, is a by-product of some of these chemical reactions. Most living things, including yeast, contain an enzyme that helps the breakdown of hydrogen peroxide into other substances that are not poisonous. The reaction between hydrogen peroxide and yeast is similar to the breakdown of hydrogen peroxide that can occur in the cells of your body.

When yeast and hydrogen peroxide are mixed together, hydrogen peroxide ($H_2O_2$) is broken down into water ($H_2O$) and oxygen gas ($O_2$) as shown below.

$$2H_2O_2 \xrightarrow{\text{Yeast}} 2H_2O + O_2\uparrow$$

Hydrogen Peroxide, in the presence of Yeast ⟶ Water and Oxygen (gas)

**Your Task**

A number of different variables, such as the concentration of the hydrogen peroxide solution or the temperature at which the reaction occurs, can affect the rate at which yeast breaks down hydrogen peroxide. You and your partner will design and conduct an experiment to explore the effect of one of these factors on the rate of the breakdown of hydrogen peroxide by yeast.

During this activity you will work with a lab partner (or possibly two partners). You must keep your own individual lab notes because after you finish, you will work independently to write a lab report about your experiment.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided. You may use additional materials or equipment if they are available. The styrofoam cups should be used to hold warm water or ice.

| | |
|---|---|
| **Hydrogen peroxide** | **Forceps** |
| **Packet of yeast** | **5 paper cups** |
| **20 pieces of felt** | **1 small lid for paper cup** |
| **5 test tubes** | **2 Styrofoam cups** |
| **Test tube rack** | **2 lids for styrofoam cups** |
| **Labeling dots** | **3 plastic spoons** |
| **Access to ice or ice water** | **Graduated cylinder** |
| **Access to warm water (50º–60ºC)** | **Thermometer** |
| **Access to tap water** | **Test tube brush** |
| **Clock or watch with a second hand** | |
| **Paper towels for cleanup** | |
| **Splash-proof goggles and aprons for each student** | |

## Steps to Follow

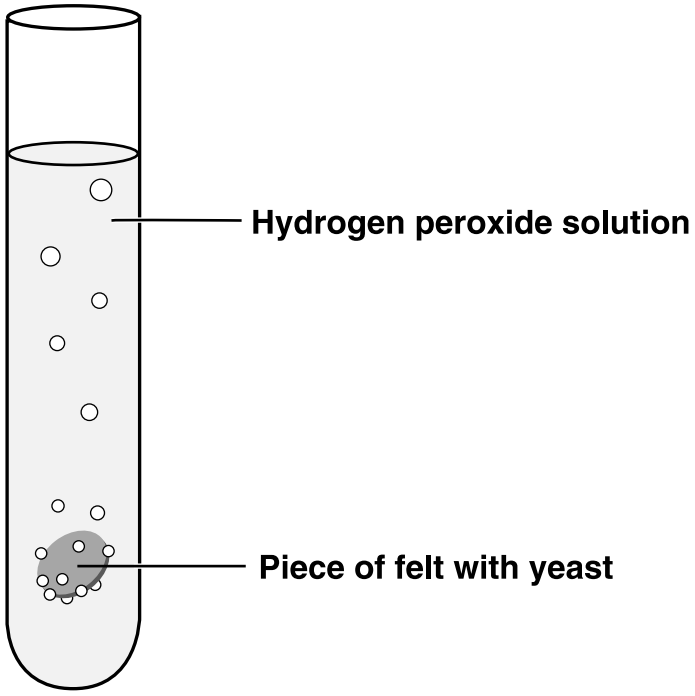
**Part A** **Observe what happens when yeast is added to hydrogen peroxide.** Follow the instructions below.

1. Combine 1 packet of yeast with 100 mL of tap water at room temperature in a paper cup and mix well with a plastic spoon. This will serve as your supply of yeast solution for the experiment. (You may want to cover the paper cup containing the yeast solution with the small lid to reduce the odor.)

2. Pinch the rim of a paper cup to make a spout for pouring. Dilute 10 mL of hydrogen peroxide with 190 mL of tap water at room temperature in this paper cup. This will serve as your supply of hydrogen peroxide solution for the experiment.

3. Fill one test tube about 3/4 full with the hydrogen peroxide solution. Using the forceps, soak a piece of felt in the yeast solution and then drop it into the test tube containing hydrogen peroxide solution. The felt should sink to the bottom of the test tube. As the yeast helps break down the hydrogen peroxide, oxygen gas bubbles are formed on the felt and it rises to the top (see diagram on next page).

In this experiment, you will measure how long it takes for the piece of felt soaked with yeast solution to sink and rise in the test tube. The amount of time it takes for the felt to sink and rise in the test tube indicates how quickly oxygen bubbles are being formed as the hydrogen peroxide is broken down.



**Part B**

1. **Select one variable (temperature or concentration of the hydrogen peroxide solution).** You will explore the effect of this variable on the rate of breakdown of hydrogen peroxide by yeast.

2. **In your words, clearly state the problem you are going to investigate.** Include a clear identification of the independent and dependent variables that will be studied. Write your statement of the problem on page 6.

3. **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem, should control variables, and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate.

   Write your experimental design on page 6. Show your design to your teacher before you begin your experiment.

4. **After receiving approval from your teacher, work with your partner to carry out your experiment.** Your teacher's approval does not necessarily mean that your teacher thinks your experiment is well designed. It simply means that in your teacher's judgment your experiment is not dangerous or likely to cause an unnecessary mess.

5. **While conducting your experiment, take notes on pages 6–10.** Include the results of your experiment. Tables, charts and/or graphs, should be used where appropriate and should be properly labeled.

Your notes will **not** be scored, but they will be helpful to you later as you work independently to write about your experiment and results. You **must** keep your own notes because you will not work with your partner when you write your lab report.

When you have finished your experiments, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.

*(Students are provided with four blank pages for their notes, as well as a grid for tables, charts or graphs.)*

# Directions for Writing Your Laboratory Report

Working on your own, summarize your experiment and results. You may use your own notes that you took previously while working with your partner. You may wish to write a first draft of your lab report on scratch paper. Space for your final report is provided on the following pages in this booklet. You will have approximately 30 minutes to complete your report.

Your report should include the following:

- **A clear statement of the problem you investigated.** Include a clear identification of the independent and dependent variables that were studied.

- **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone else could easily replicate your experiment.

- **The results of your experiment**. Tables, charts and/or graphs should be used where appropriate and should be properly labeled. Space for your data is provided on page 17.

- **Your conclusions from the experiment.** Your conclusions should be fully supported by data.

- **Comments about how valid you think your conclusions are.** In other words, how much confidence do you have in your results and conclusions? Any factors that contribute to a lack of confidence in the results or conclusions should be discussed. Also, include ways that your experiment could be improved if you were to do it again.

*(Students are provided with four lined pages for their reports, as well as a grid for tabled, charts or graphs.)*

# CAPT Experimentation Questions

## Tiny Bubbles

Students in a science class conducted experiments to explore the effects of various factors on the reaction of yeast and hydrogen peroxide. In the reaction, hydrogen peroxide ($H_2O_2$) is broken down into water ($H_2O$) and oxygen gas ($O_2$). Two groups of students decided to investigate the effect of the concentration of the hydrogen peroxide solution on the reaction. Their experimental procedures and results are shown below:

**Group A** We took four test tubes and placed the following in each:

Test tube 1—20 mL of hydrogen peroxide and 5 mL of water
Test tube 2—15 mL of hydrogen peroxide and 5 mL of water
Test tube 3—10 mL of hydrogen peroxide and 5 mL of water
Test tube 4—5 mL of hydrogen peroxide and 5 mL of water

For each test tube we did the following:
We dipped a piece of felt in a yeast and water mixture and placed it in a test tube. The piece of felt sank. We then measured the time it took for the felt to rise to the top of the test tube. Our results are as follows:

| Test Tube | Time For Felt to Rise |
|---|---|
| 1 | 24 seconds |
| 2 | 48 seconds |
| 3 | 55 seconds |
| 4 | 61 seconds |

**Group B** We took 5 test tubes and placed the following amounts of hydrogen peroxide and water into each:

| Test Tube | Hydrogen Peroxide | Water |
|---|---|---|
| 1 | 20 mL | 0 mL |
| 2 | 15 mL | 5 mL |
| 3 | 10 mL | 10 mL |
| 4 | 5 mL | 15 mL |
| 5 | 0 mL | 20 mL |

We then cut 5 pieces of felt and dipped each piece into a mixture of 1 packet of yeast and 200 mL of water. We then placed a piece of felt in each of the test tubes and recorded our observations. Our results are shown below:

| Test Tube | Observations |
|---|---|
| 1 | very cloudy, a lot of bubbles, felt sank and then rose quickly |
| 2 | cloudy, bubbles, felt sank and then rose slowly |
| 3 | cloudy, some bubbles, felt sank and then rose slowly |
| 4 | a little cloudy, a few bubbles, felt sank and then rose very slowly |
| 5 | clear, no bubbles formed, felt sank and did not rise |

**1.** Compare Group A's and Group B's experiments. Which experiment, if either, is better designed? Explain your answer fully.

**2.** Group B was not sure why the felt did not rise to the top in test tube 5. What is the most likely reason for this? Explain your answer fully.

Group C designed and carried out the following experiment.

1. We placed a solution of hydrogen peroxide and water into four test tubes.
2. We put one test tube in a beaker of ice water, one test tube in a beaker of warm water, one test tube in a beaker of hot water, and one test tube was left at room temperature. We measured the temperature in each test tube.
3. We dipped 4 small pieces of felt into a yeast solution and dropped them into the test tubes. We recorded our observations and measured the length of time for the felt to rise in each test tube. Our data is shown below.

| **Test Tube** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| **Temperature** | 8°C | 22°C | 30°C | 41°C |
| **Observations** | a few bubbles formed | bubbles formed | bubbles formed | a lot of bubbles formed |
| **Time for felt to rise** | 47 seconds | 32 seconds | 23 seconds | 17 seconds |

**3.** Draw a graph of Group C's results. Be sure to label your graph.

| | |
|---|---|
| **Hydrogen peroxide** | **A weak acid** |
| **Yeast** | **A weak base** |
| **Felt** | **pH paper** |
| **5 test tubes** | **Ice** |
| **Test tube rack** | **Warm water** |
| **Marking pencil** | **Tap water** |
| **Tweezers** | **Balance** |
| **Scissors** | **Clock or watch with a second hand** |
| **5 paper cups** | |
| **3 plastic spoons** | |
| **Graduated cylinder** | |
| **1 thermometer** | |
| **3 beakers** | |
| **Paper towels for cleanup** | |
| **Splash proof goggles and aprons for each student** | |

**4.** The equipment listed above is available for your use. Using the available equipment, design an experiment to investigate whether or not pH affects the reaction between hydrogen peroxide and yeast. Your experiment should be clear enough so that someone else could easily replicate it.